Absolute and Relative Gravity Measurements at the Istituto Nazionale di Ricerca Metrologica (INRIM) of Turin (Italy) in June 2006

Final Report

September 2006

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Foreword

Absolute gravity measurements were carried out at the Istituto Nazionale di Ricerca Metrologica (I.N.RI.M.) in Turin on the invitation of Dr. A. Germak and Dr. G. D'Agostino. The objective is to compare with the observations of the IMGC-02 absolute gravimeter of the INRIM.
The absolute gravimeter FG5#216 from the European Center for Geodynamics and Seismology (ECGS) was operated by Olivier Francis from the University of Luxembourg and Gilles Celli from the ECGS.
Relative gravity measurements were carried out with the spring gravimeter Scintrex CG5#008. The vertical gravity gradient was measured at the absolute gravimeter site and a network was observed in the Force Laboratory of the INRIM.

1. Absolute Gravity measurements

The absolute gravity observations were performed in the absolute gravity room. A picture of the set-up of the absolute gravimeter FG5#216 on the site is shown in Figure 1.

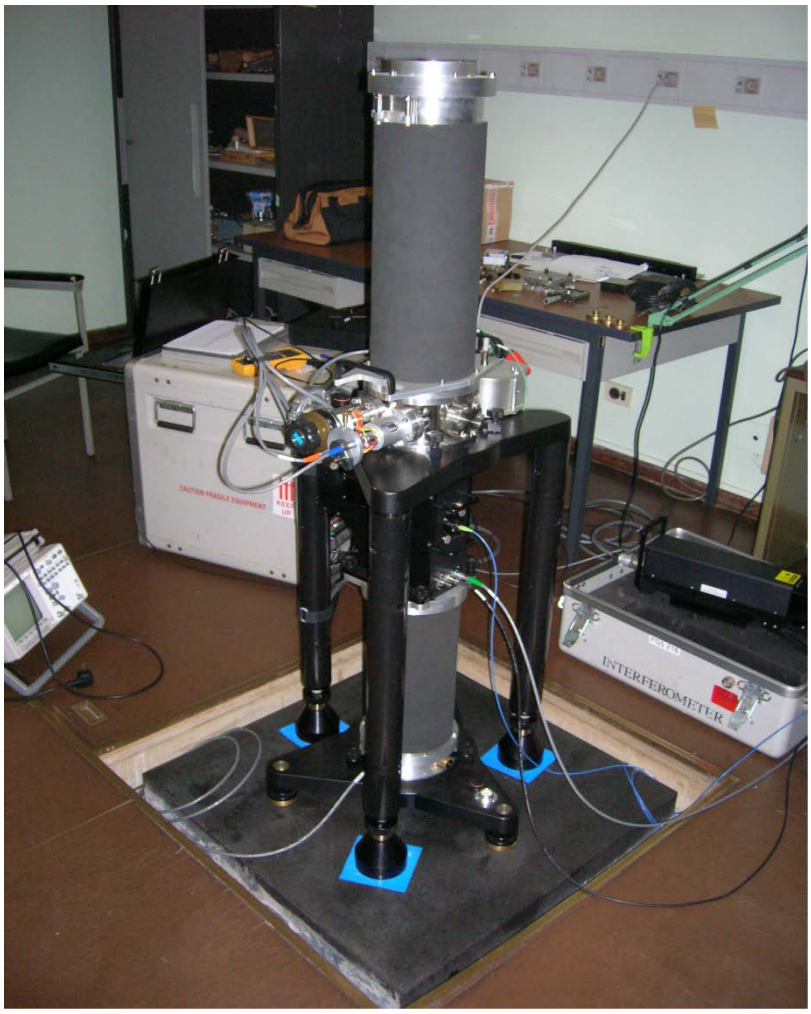


Figure 1. The FG5#216 from the ECGS in the absolute gravity laboratory of the INRIM in Turin.

1.1 Data processing

Raw data from the absolute gravimeters consist of vectors of time and position of the falling object during the drops. To obtain the gravity value, a linear equation representing the equation of motion is fit to the raw data including the gravity gradient which has been measured with relative meters.
The data processing follows the protocol adopted during absolute gravimeters comparisons at the BIPM in Sèvres (Francis and van Dam, 2003). Geophysical corrections are applied to the raw gravity data: Earth tides using modelled tidal parameters, atmospheric pressure effect using a constant admittance, and the polar motion effect using pole positions from IERS.
The g-soft version 6.0 software from Micro-g Solutions Inc. was used for the processing. All the text outputs as well as some figures are compiled in the annexes of this report for future reference.

1.2 Vertical Gravity Gradient

The vertical gravity gradient was measured with a relative spring gravimeter Scintrex CG5. This gradient is needed to linearize the equation of motion but also to transfer the measured absolute gravity value from the reference height around 1.3 m to the floor. The final value of the linear vertical gravity gradient is –2.645 ± 0.007 microGal/cm at the pier where the absolute gravimeter measurements were performed.

1.3 Results of the absolute gravity measurements

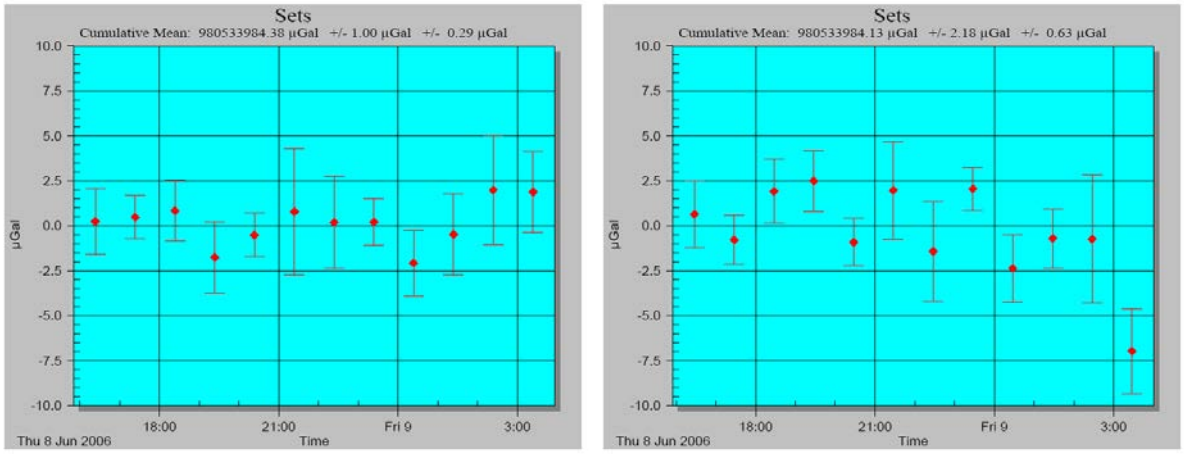
The FG5#216 stayed on the pier in the gravity lab from the 5th to the 9th of June. A total of 8100 drops were taken in three different sessions. The results are summarized in table 1.
A time interval of 10 second was chosen for the two first ones (21 and 36 sets of 100 drops). A time interval of 5 second was tried for the last session (12 sets of 200 drops) to avoid the aliaising of the microseismic noise. This last choice proves to be efficient: the mean value of gravity stayed unchanged but one can observe a drastic improvement in the mean set standard deviation which dropped from about 2 microgal to 0.5 microgal.

Table 1. Results of the absolute gravity measurements at the pier of the gravity laboratory of the INRIM in Turin.

Date	Gravity value at 1.30 m /microgal	Mean Set Standard Deviation /microgal
5/6 Nov. 2006	980 533 984.4	1.7
6/8 Nov. 2006	980 533 984.1	2.2
8/9 Nov. 2006	980 533 984.4	0.5

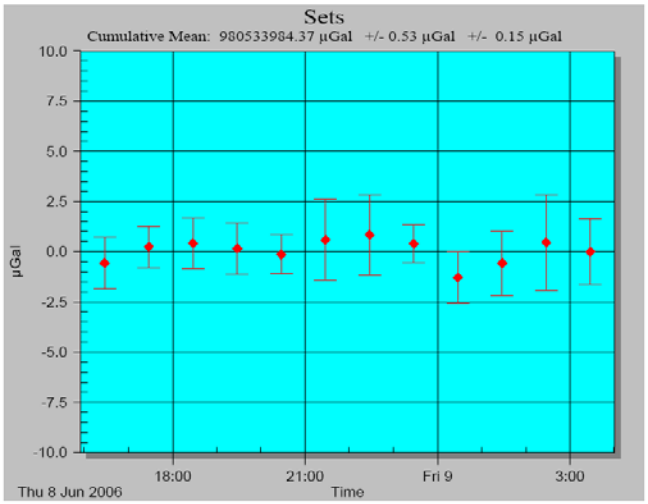
The time interval of the last set is 5 second. During the reprocessing of the data, we processed the complete set of data. Then we selected one data over two, equivalent to a time interval of 10 second. By comparing Figures 2, we can clearly see the effect of the aliaising (projection of the high frequency noise in the low frequency) of the microseismic noise on the results: for the 10 second interval, the mean set standard deviation significantly increases. The

superspring is intended to reduce the aliaising effect but at noisy site, the efficiency is somewhat limited. The good news is that the mean value is practically not affected.



A **B**

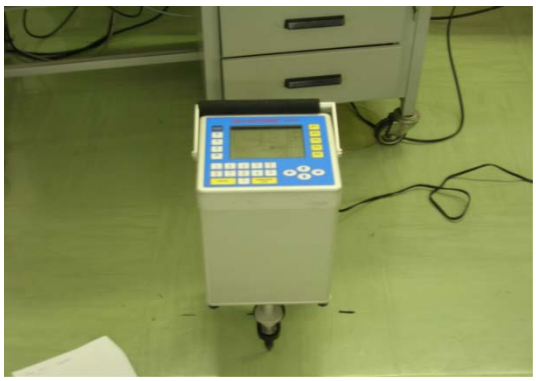
Figures 2. Absolute gravity values of the last session. **A.** time interval of 5 second and 200 drops per set; **B**. time interval of 10 second and 100 drops per set; **C.** time interval of 5 second and 100 drops per set.



C

2. Relative gravity measurements

During our stay at the INRIM, we had the opportunity to perform some relative gravity measurements between three different sites in the Force laboratory. A picture of the different locations is displayed in Figures 2.



Site A

Site B1

Site B2

Figures 3. Sites of the relative network in the Force Laboratory.

Due to an accidental power supply disconnection, the batteries of the Scintrex were empty and the gravimeter cooled down a few hours before the measurements. After 1 hour of warming up, the gravimeter was ready to take observations. In consequence, we observed a huge linear drift in the gravity data. Fortunately, it did not affect the precision of the measurements. The results of the gravity ties are given in Table 2. The R.MS. is the formal error of the least square adjustment of the observations taking the precision of the measurements (which is estimated using the standard deviation of the raw data over the integration time).

Table 2. Relative ties in the Force laboratory of the INRIM in Turin.

Site	gravity difference /microGal	RMS /microGal
A	0	
B1	1753.2	0.7
B2	1755.9	0.9

Reference

Francis O., van Dam T.M., Processing of the Absolute data of the ICAG01, Cahiers du Centre Européen de Géodynamique et de Séismologie, vol. 22, 45-48, 2003.

5-6 June 2006

STATION: TURIN

City:	Turin	Country:	Italy
Location:	INRIM	Particularity:	
Situation:	Gravity Laboratory	Remarks:	
Date:	5/6 June 2006		

Code number:	
Latitude:	45.0170 degrees
Longitude:	7.64270 degrees
Elevation:	236 m
Gradient:	-2.645 μgal/cm
Reference height:	12.85 mm
Meter:	FG5
S/N:	216

Ocean loading correction (μgal, Greenwich degree)

Wave	M_2	S_2	K_1	O_1	N_2	P_1	K_2	Q_1	M_f	M_m	S_{sa}
Ampl.	1.675	0.566	0.250	0.147	0.353	0.077	0.156	0.043	0.0	0.0	0.0
Phase:	61.6	33.5	56.6	159.5	83.2	62.1	39.1	-139.5	0.0	0.0	0.0

Polar motion correction			**Air pressure correction**	
X-coordinate:	0.1232	arc seconds	Nominal air pressure:	985.22 mbar
Y-coordinate:	0.3271	arc seconds	Barometric admittance factor:	0.3 μgal/mbar

Gravity

Set gravity mean:	**9 80 533 984.42**	Microgal
Set std. dev.:	1.71	microgal
Mean std. dev.:	18.85	microgal
Number of sets:	21	
Number of drops per set:	100	
Drop interval:	10 seconds	
Set interval:	60 minutes	
Nominal/datum height:	130.0 cm	

Author: O. Francis University of Luxembourg

Date: September 20,2006

Project file

Site Code: IMGC
Lat: 45.01700 Long: 7.64270 Elev: 236.00 m
Reference Height: 12.85 cm
Datum Height: 130.00 cm
Gradient: -2.645 µGal/cm
Nominal Air Pressure: 985.22 mBar
Barometric Admittance Factor: 0.30
Polar Motion Coord: 0.1232 " 0.3271 "
Earth Tide (ETGTAB) Selected
Potential Filename: C:\Program Files\Micro-g Solutions Inc\gWavefiles\Etcpot.dat
Delta Factor Filename: F:\ABSOLU\DATA\2006\Turin\torino.dff
Delta Factors

Start	Stop	Amplitude	Phase	Term
0.000000	0.002427	1.000000	0.0000	DC
0.002428	0.249951	1.160000	0.0000	Long
0.721500	0.906315	1.154250	0.0000	Q1
0.921941	0.974188	1.154240	0.0000	O1
0.989049	0.998028	1.149150	0.0000	P1
0.999853	1.216397	1.134890	0.0000	K1
1.719381	1.906462	1.161720	0.0000	N2
1.923766	1.976926	1.161720	0.0000	M2
1.991787	2.002885	1.161720	0.0000	S2
2.003032	2.182843	1.161720	0.0000	K2
2.753244	3.081254	1.07338	0.0000	M3
3.791964	3.937897	1.03900	0.0000	M4

Ocean Load ON, Filename: F:\ABSOLU\DATA\2006\Turin\torino.olf

Waves:	M2	S2	K1	O1	N2	P1	K2	Q1	Mf	Mm	Ssa
Amplitude (µGal):	1.675	0.566	0.250	0.147	0.353	0.077	0.156	0.043	0.000	0.000	0.000
Phase (deg):	61.6	33.5	56.6	159.5	83.2	62.1	39.1	-139.5	0.0	0.0	0.0

Instrument Data
Meter Type: FG5
Meter S/N: 216
Factory Height: 116.40 cm
Rubidium Frequency: 10000000.01020 Hz
Laser: WEO100 (187)
ID: 632.99117754 nm (0.40 V)
IE: 632.99119473 nm (-0.08 V)
IF: 632.99121259 nm (-0.45 V)
IG: 632.99123023 nm (-1.18 V)
IH: 632.99136890 nm (-1.78 V)
II: 632.99139822 nm (-1.53 V)
IJ: 632.99142704 nm (-1.30 V)
Modulation Frequency: 8333.420 Hz

Processing Results
Date: 06/06/06
Time: 00:53:12
DOY: 157
Year: 2006
Time Offset (D h:m:s): 0 0:0:0
Gravity: 980533984.42 µGal
Set Scatter: 1.71 µGal
Measurement Precision: 0.37 µGal
Total Uncertainty: 0.37 µGal
Number of Sets Collected: 21
Number of Sets Processed: 21
Set #s Processed: 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21

Number of Sets NOT Processed: 0
Set #s NOT Processed:
Number of Drops/Set: 100
Total Drops Accepted: 2061
Total Drops Rejected: 39
Total Fringes Acquired: 700
Fringe Start: 7
Processed Fringes: 613
GuideCard Multiplex: 4
GuideCard Scale Factor: 250

Acquisition Settings
Set Interval: 60 min
Drop Interval: 10 sec
Number of Sets: 24
Number of Drops: 100

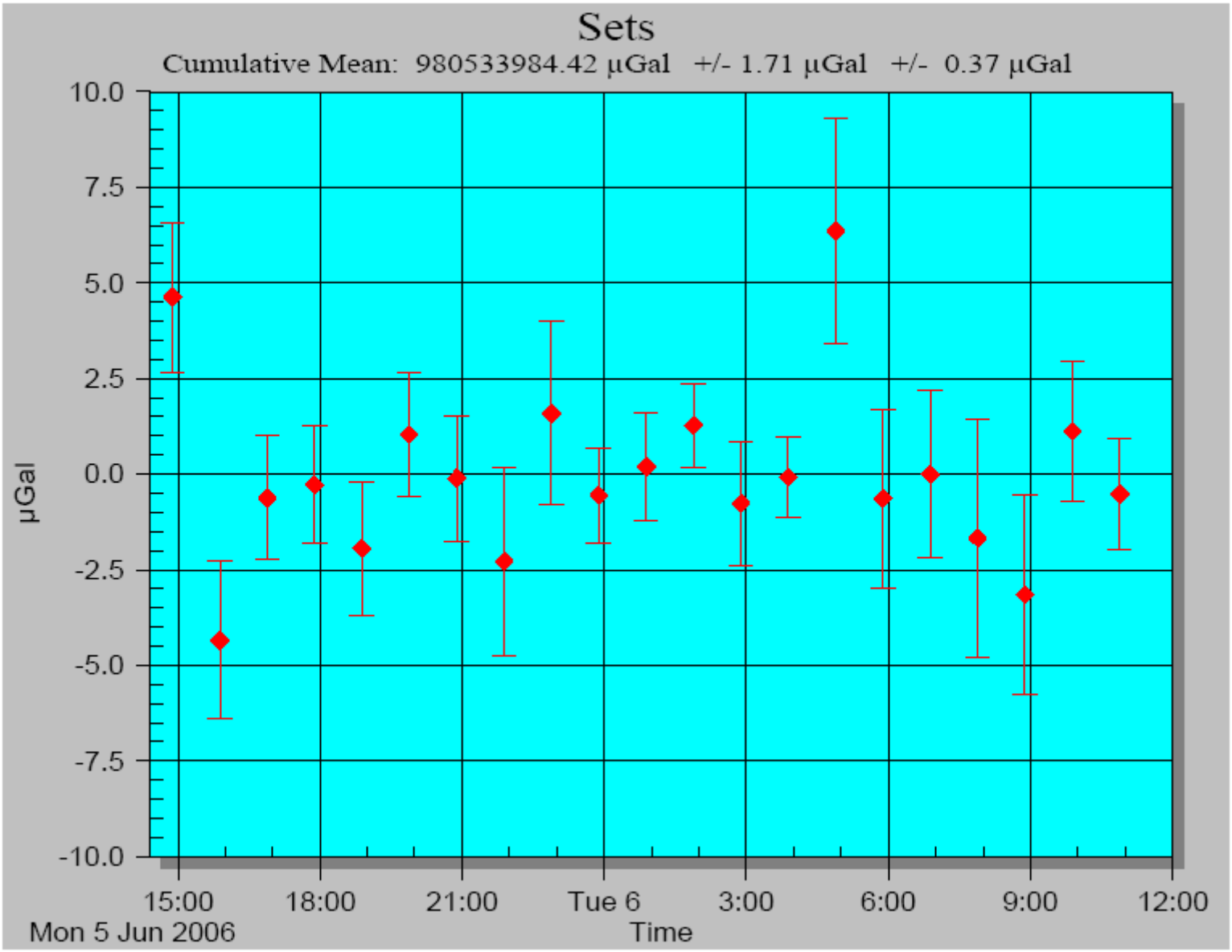
Gravity Corrections
Earth Tide (ETGTAB): -11.69 µGal
Ocean Load: 0.04 µGal
Polar Motion: -1.50 µGal
Barometric Pressure: 1.33 µGal
Datum Height: -1.98 µGal
Reference Xo: -0.00 µGal

Uncertainties
Sigma Reject: 3.00
Earth Tide Factor: 0.000
Average Earth Tide Uncertainty: 0.00 µGal
Ocean Load Factor: 0.00
Average Ocean Load Uncertainty: 0.00 µGal
Barometric: 0.00 µGal
Polar Motion: 0.00 µGal
Laser: 0.00 µGal
Clock: 0.00 µGal
System Type: 0.00 µGal
Tidal Swell: 0.00 µGal
Water Table: 0.00 µGal
Unmodeled: 0.00 µGal
System Setup: 0.00 µGal
Gradient: 0.00 µGal (0.00 µGal/cm)

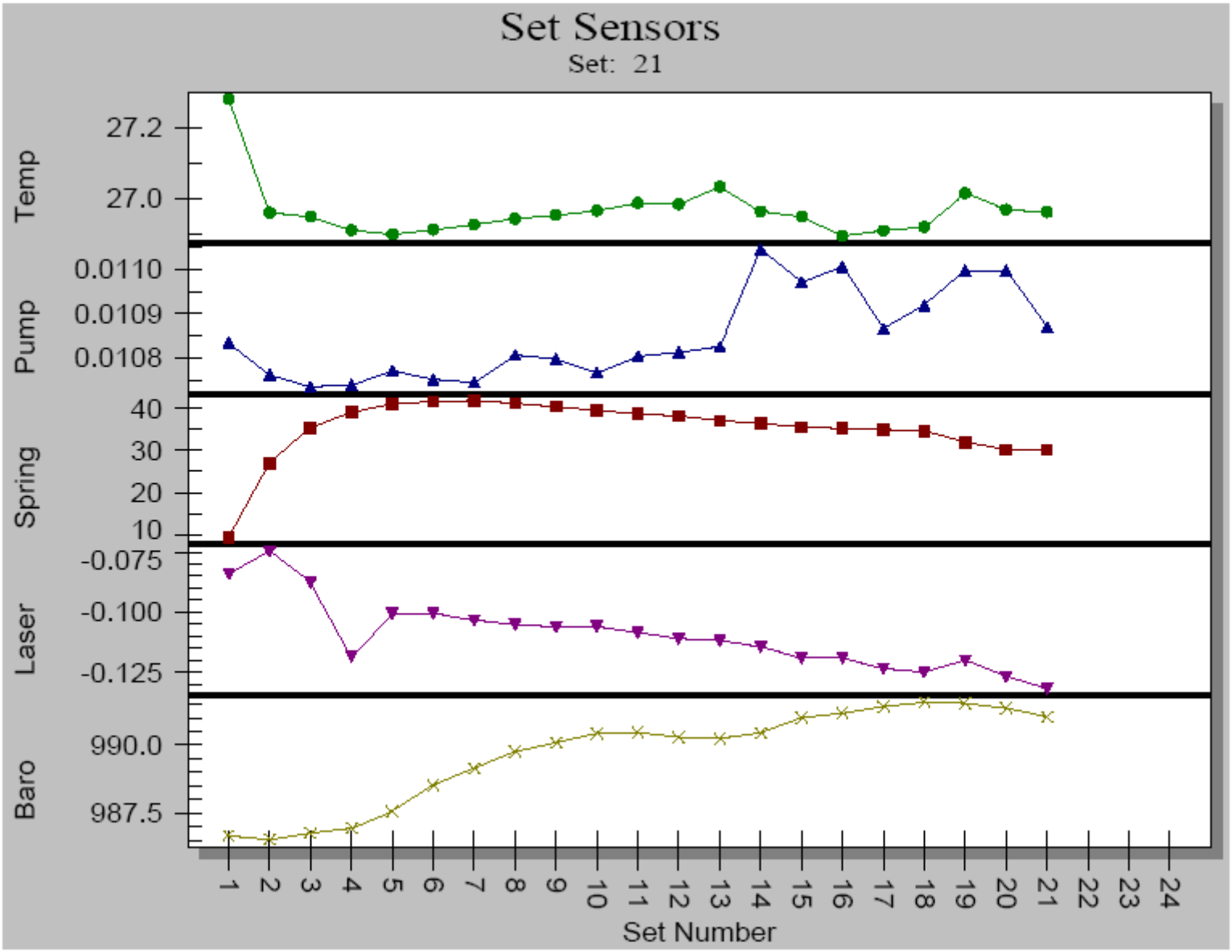
Set File

Source Data Filename: tu20060605
g Acquisition Version: 1.082300
g Processing Version: 6.060320

Set	Time	DOY	Year	Gravity	Sigma	Error	Uncert	Tide	Load	Baro	Polar	Datum	Refxo	Temp	Pres	Accept	Reject
1	14:53:15	156	2006	980533989.055	19.562	1.956	1.956	-22.566	0.884	0.432	-1.504	-1.984	-0.002	27.282	986.658	100	0
2	15:53:11	156	2006	980533980.076	20.310	2.062	2.062	-17.817	1.075	0.389	-1.504	-1.984	-0.002	26.960	986.517	97	3
3	16:53:15	156	2006	980533983.804	16.254	1.625	1.625	-11.045	0.995	0.460	-1.504	-1.984	-0.002	26.949	986.753	100	0
4	17:53:15	156	2006	980533984.141	15.397	1.540	1.540	-5.573	0.648	0.515	-1.504	-1.984	-0.002	26.911	986.936	100	0
5	18:53:15	156	2006	980533982.475	17.399	1.740	1.740	-4.438	0.103	0.700	-1.504	-1.984	-0.002	26.899	987.555	100	0
6	19:52:47	156	2006	980533985.455	15.631	1.621	1.621	-9.392	-0.513	0.989	-1.504	-1.984	-0.002	26.912	988.517	93	7
7	20:53:15	156	2006	980533984.315	16.467	1.647	1.647	-20.615	-1.071	1.176	-1.504	-1.984	-0.002	26.926	989.139	100	0
8	21:53:20	156	2006	980533982.140	24.035	2.466	2.466	-35.980	-1.423	1.357	-1.504	-1.984	-0.002	26.943	989.745	95	5
9	22:53:04	156	2006	980533986.009	23.357	2.396	2.396	-52.016	-1.489	1.462	-1.504	-1.984	-0.002	26.953	990.093	95	5
10	23:53:03	156	2006	980533983.862	12.188	1.238	1.238	-64.847	-1.249	1.561	-1.504	-1.984	-0.002	26.966	990.425	97	3
11	00:53:15	157	2006	980533984.618	13.883	1.395	1.395	-70.776	-0.749	1.572	-1.504	-1.984	-0.002	26.987	990.461	99	1
12	01:53:13	157	2006	980533985.702	10.749	1.086	1.086	-67.441	-0.107	1.521	-1.504	-1.984	-0.002	26.984	990.291	98	2
13	02:53:15	157	2006	980533983.655	16.138	1.614	1.614	-54.462	0.537	1.510	-1.504	-1.984	-0.002	27.034	990.254	100	0
14	03:53:17	157	2006	980533984.343	10.322	1.048	1.048	-33.518	1.037	1.568	-1.504	-1.984	-0.002	26.964	990.448	97	3
15	04:53:15	157	2006	980533990.780	29.281	2.928	2.928	-8.064	1.284	1.736	-1.504	-1.984	-0.002	26.949	991.007	100	0
16	05:53:14	157	2006	980533983.778	23.391	2.351	2.351	17.436	1.234	1.784	-1.504	-1.984	-0.002	26.895	991.167	99	1
17	06:53:11	157	2006	980533984.417	21.804	2.203	2.203	38.351	0.911	1.860	-1.504	-1.984	-0.002	26.909	991.419	98	2
18	07:53:14	157	2006	980533982.750	30.956	3.111	3.111	50.955	0.404	1.907	-1.504	-1.984	-0.002	26.920	991.577	99	1
19	08:53:12	157	2006	980533981.266	26.140	2.627	2.627	53.100	-0.151	1.897	-1.504	-1.984	-0.002	27.015	991.543	99	1
20	09:53:18	157	2006	980533985.536	18.216	1.840	1.840	44.817	-0.613	1.842	-1.504	-1.984	-0.002	26.968	991.361	98	2
21	10:53:03	157	2006	980533983.899	14.311	1.453	1.453	28.393	-0.864	1.747	-1.504	-1.984	-0.002	26.962	991.042	97	3


Sets
Cumulative Mean: 980533984.42 µGal +/- 1.71 µGal +/- 0.37 µGal
10.0
7.5
5.0
2.5
0.0
-2.5
-5.0
-7.5
-10.0
µGal
15:00
18:00
21:00
Tue 6
3:00
6:00
9:00
12:00
Mon 5 Jun 2006
Time


Set Corrections
Set: 21
Tide
50
0
-50
Load
1
0
-1
Polar
-1.4
-1.5
-1.6
Baro
1.5
1.0
0.5
Datum
RefXo
-0.0017
-0.0018
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Set Number


Set Sensors
Set: 21
Temp
27.2
27.0
Pump
0.0110
0.0109
0.0108
Spring
40
30
20
10
Laser
-0.075
-0.100
-0.125
Baro
990.0
987.5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Set Number

6-8 June 2006

STATION: TURIN

City:	Turin	Country:	Italy
Location:	INRIM	Particularity:	
Situation:	Gravity Laboratory	Remarks:	
Date:	6/8 June 2006		

Code number:	
Latitude:	45.0170 degrees
Longitude:	7.64270 degrees
Elevation:	236 m
Gradient:	-2.645 μgal/cm
Reference height:	12.85 mm
Meter:	FG5
S/N:	216

Ocean loading correction (μgal, -Greenwich degree)

Wave	M_2	S_2	K_1	O_1	N_2	P_1	K_2	Q_1	M_f	M_m	S_{sa}
Ampl.	1.675	0.566	0.250	0.147	0.353	0.077	0.156	0.043	0.0	0.0	0.0
Phase:	61.6	33.5	56.6	159.5	83.2	62.1	39.1	-139.5	0.0	0.0	0.0

Polar motion correction			**Air pressure correction**	
X-coordinate:	0.1232	arc seconds	Nominal air pressure:	985.22 mbar
Y-coordinate:	0.3271	arc seconds	Barometric admittance factor:	0.3 μgal/mbar

Gravity

Set gravity mean:	**9 80 533 984.06**	Microgal
Set std. dev.:	2.20	microgal
Mean std. dev.:	19.39	microgal
Number of sets:	36	
Number of drops per set:	100	
Drop interval:	10 seconds	
Set interval:	60 minutes	
Nominal/datum height:	130.0 cm	

Author: O. Francis University of Luxembourg

Date: September 20,2006

Project file

Micro-g Solutions g Processing Report
File Created: 09/20/06, 14:49:27

Project Name: tu20060606
g Acquisition Version: 1.082300
g Processing Version: 6.060320

Company/Institution:
Operator:

Station Data
Name: TURIN
Site Code: IMGC
Lat: 45.01700 Long: 7.64270 Elev: 236.00 m
Reference Height: 12.85 cm
Datum Height: 130.00 cm
Gradient: -2.645 µGal/cm
Nominal Air Pressure: 985.22 mBar
Barometric Admittance Factor: 0.30
Polar Motion Coord: 0.1232 " 0.3271 "
Earth Tide (ETGTAB) Selected
Potential Filename: C:\Program Files\Micro-g Solutions Inc\gWavefiles\Etcpot.dat
Delta Factor Filename: F:\ABSOLU\DATA\2006\Turin\torino.dff
Delta Factors

Start	Stop	Amplitude	Phase	Term
0.000000	0.002427	1.000000	0.0000	DC
0.002428	0.249951	1.160000	0.0000	Long
0.721500	0.906315	1.154250	0.0000	Q1
0.921941	0.974188	1.154240	0.0000	O1
0.989049	0.998028	1.149150	0.0000	P1
0.999853	1.216397	1.134890	0.0000	K1
1.719381	1.906462	1.161720	0.0000	N2
1.923766	1.976926	1.161720	0.0000	M2
1.991787	2.002885	1.161720	0.0000	S2
2.003032	2.182843	1.161720	0.0000	K2
2.753244	3.081254	1.07338	0.0000	M3
3.791964	3.937897	1.03900	0.0000	M4

Ocean Load ON, Filename: F:\ABSOLU\DATA\2006\Turin\torino.olf

Waves:	M2	S2	K1	O1	N2	P1	K2	Q1	Mf	Mm	Ssa
Amplitude (µGal):	1.675	0.566	0.250	0.147	0.353	0.077	0.156	0.043	0.000	0.000	0.000
Phase (deg):	61.6	33.5	56.6	159.5	83.2	62.1	39.1	-139.5	0.0	0.0	0.0

Instrument Data
Meter Type: FG5
Meter S/N: 216
Factory Height: 116.40 cm
Rubidium Frequency: 10000000.01020 Hz
Laser: WEO100 (187)
ID: 632.99117754 nm (0.33 V)
IE: 632.99119473 nm (-0.14 V)
IF: 632.99121259 nm (-0.55 V)
IG: 632.99123023 nm (-0.93 V)
IH: 632.99136890 nm (-1.78 V)
II: 632.99139822 nm (-1.53 V)
IJ: 632.99142704 nm (-1.30 V)
Modulation Frequency: 8333.420 Hz

Processing Results

Date: 06/07/06
Time: 08:38:15
DOY: 158
Year: 2006
Time Offset (D h:m:s): 0 0:0:0
Gravity: 980533984.06 µGal
Set Scatter: 2.20 µGal
Measurement Precision: 0.37 µGal
Total Uncertainty: 0.37 µGal
Number of Sets Collected: 36
Number of Sets Processed: 36
Set #s Processed:1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36
Number of Sets NOT Processed: 0
Set #s NOT Processed:
Number of Drops/Set: 100
Total Drops Accepted: 3500
Total Drops Rejected: 100
Total Fringes Acquired: 700
Fringe Start: 7
Processed Fringes: 613
GuideCard Multiplex: 4
GuideCard Scale Factor: 250

Acquisition Settings
Set Interval: 60 min
Drop Interval: 10 sec
Number of Sets: 36
Number of Drops: 100

Gravity Corrections
Earth Tide (ETGTAB): -24.83 µGal
Ocean Load: -0.06 µGal
Polar Motion: -1.50 µGal
Barometric Pressure: 2.45 µGal
Datum Height: -1.98 µGal
Reference Xo: -0.00 µGal

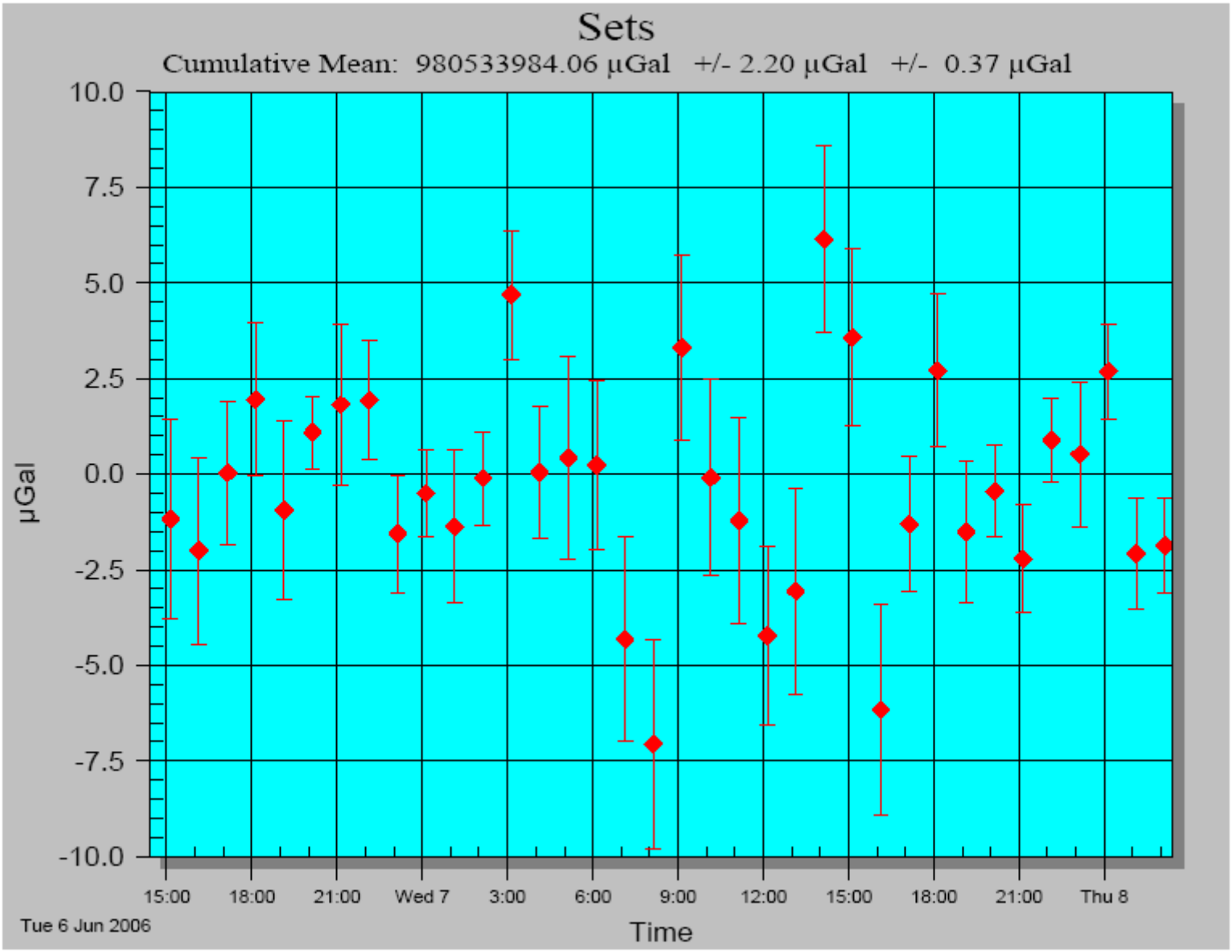
Uncertainties
Sigma Reject: 3.00
Earth Tide Factor: 0.000
Average Earth Tide Uncertainty: 0.00 µGal
Ocean Load Factor: 0.00
Average Ocean Load Uncertainty: 0.00 µGal
Barometric: 0.00 µGal
Polar Motion: 0.00 µGal
Laser: 0.00 µGal
Clock: 0.00 µGal
System Type: 0.00 µGal
Tidal Swell: 0.00 µGal
Water Table: 0.00 µGal
Unmodeled: 0.00 µGal
System Setup: 0.00 µGal
Gradient: 0.00 µGal (0.00 µGal/cm)

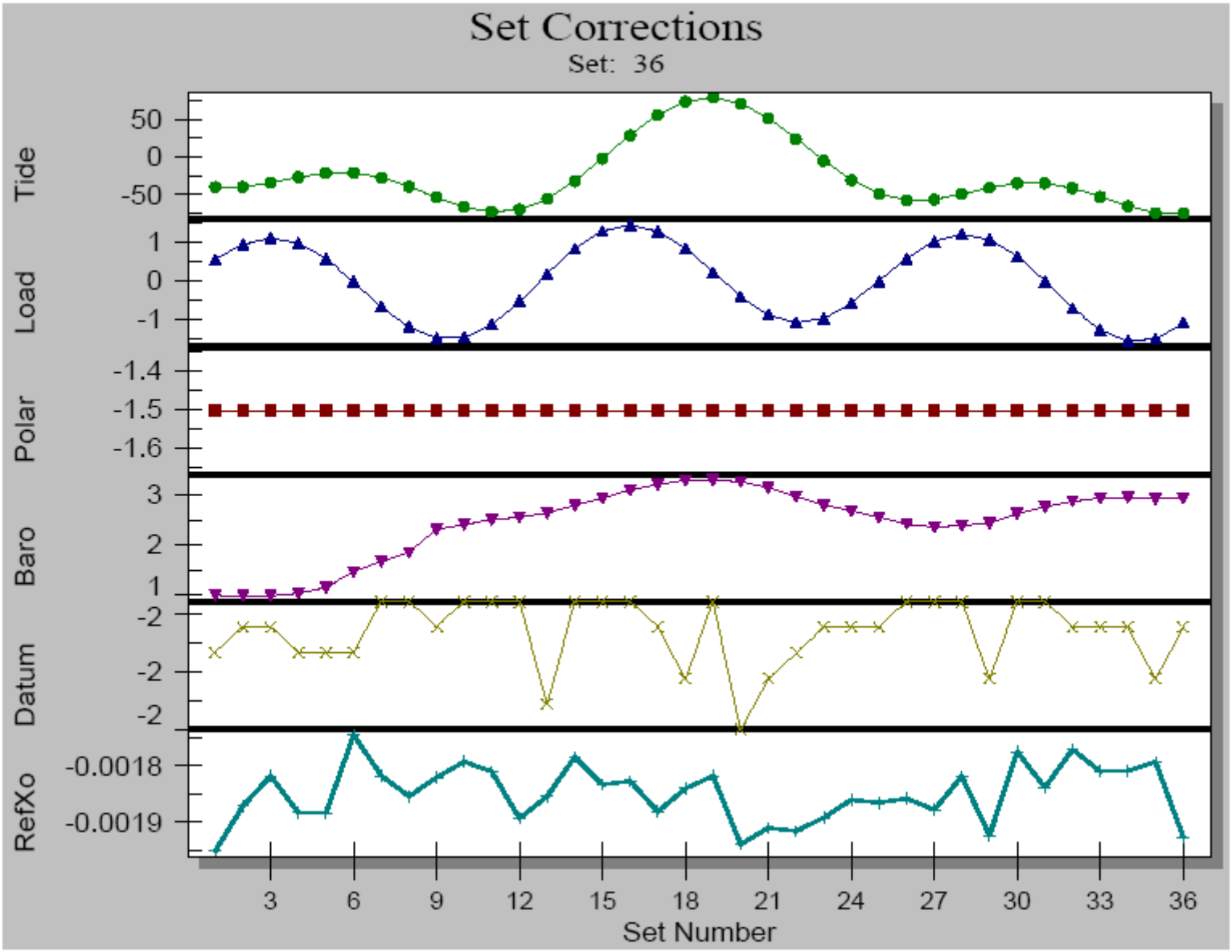
Set File

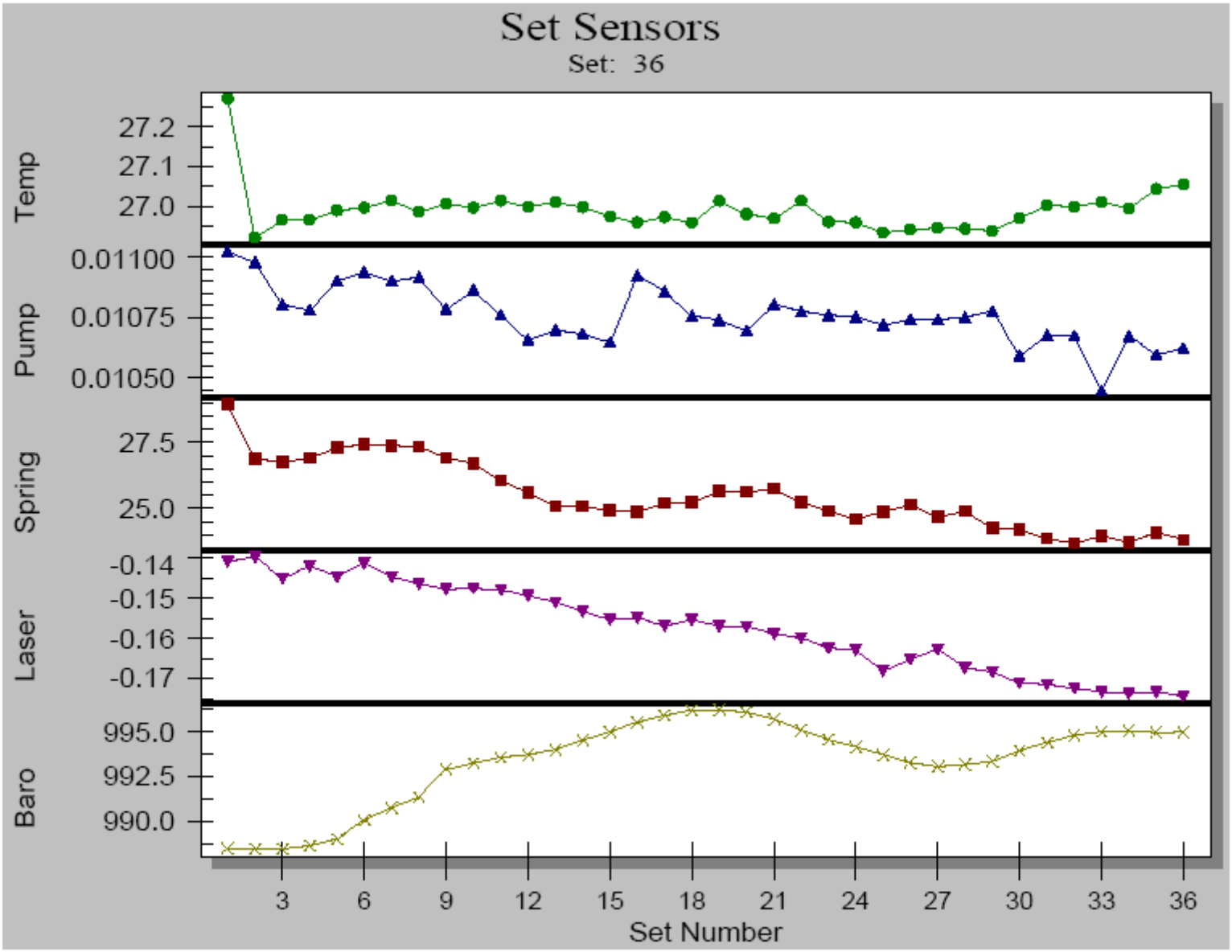
Source Data Filename: tu20060606
g Acquisition Version: 1.082300
g Processing Version: 6.060320

Set	Time	DOY	Year	Gravity	Sigma	Error	Uncert	Tide	Load	Baro	Polar	Datum	Refxo	Temp	Pres	Accept	Reject
1	15:08:05	157	2006	980533982.891	25.309	2.597	2.597	-40.218	0.542	0.991	-1.504	-1.984	-0.002	27.272	988.525	95	5
2	16:08:15	157	2006	980533982.058	24.172	2.442	2.442	-40.083	0.935	0.980	-1.504	-1.984	-0.002	26.920	988.488	98	2
3	17:08:27	157	2006	980533984.092	18.557	1.884	1.884	-34.461	1.094	0.982	-1.504	-1.984	-0.002	26.966	988.492	97	3
4	18:08:15	157	2006	980533986.016	19.667	2.007	2.007	-27.001	0.963	1.035	-1.504	-1.984	-0.002	26.966	988.669	96	4
5	19:08:05	157	2006	980533983.119	22.710	2.318	2.318	-21.593	0.561	1.146	-1.504	-1.984	-0.002	26.989	989.040	96	4
6	20:07:59	157	2006	980533985.147	9.204	0.939	0.939	-21.345	-0.027	1.459	-1.504	-1.984	-0.002	26.996	990.084	96	4
7	21:08:15	157	2006	980533985.874	21.021	2.102	2.102	-27.639	-0.667	1.663	-1.504	-1.984	-0.002	27.015	990.763	100	0
8	22:08:15	157	2006	980533985.996	15.462	1.554	1.554	-39.474	-1.198	1.841	-1.504	-1.984	-0.002	26.986	991.355	99	1
9	23:08:21	157	2006	980533982.498	15.174	1.533	1.533	-53.885	-1.492	2.302	-1.504	-1.984	-0.002	27.005	992.894	98	2
10	00:08:15	158	2006	980533983.557	11.495	1.149	1.149	-66.524	-1.469	2.407	-1.504	-1.984	-0.002	26.996	993.245	100	0
11	01:08:15	158	2006	980533982.682	20.024	2.002	2.002	-73.061	-1.127	2.505	-1.504	-1.984	-0.002	27.013	993.570	100	0
12	02:08:19	158	2006	980533983.955	12.164	1.223	1.223	-70.113	-0.538	2.554	-1.504	-1.984	-0.002	26.998	993.734	99	1
13	03:08:23	158	2006	980533988.754	16.129	1.682	1.682	-56.289	0.166	2.635	-1.504	-1.984	-0.002	27.010	994.002	92	8
14	04:08:11	158	2006	980533984.105	17.275	1.736	1.736	-32.778	0.819	2.787	-1.504	-1.984	-0.002	26.997	994.511	99	1
15	05:08:18	158	2006	980533984.497	26.332	2.646	2.646	-2.693	1.279	2.931	-1.504	-1.984	-0.002	26.974	994.990	99	1
16	06:08:15	158	2006	980533984.308	22.111	2.211	2.211	28.732	1.438	3.093	-1.504	-1.984	-0.002	26.958	995.529	100	0
17	07:08:12	158	2006	980533979.746	26.523	2.679	2.679	55.956	1.268	3.205	-1.504	-1.984	-0.002	26.972	995.904	98	2
18	08:07:46	158	2006	980533977.004	26.465	2.744	2.744	73.881	0.823	3.293	-1.504	-1.984	-0.002	26.958	996.197	93	7
19	09:08:12	158	2006	980533987.369	24.136	2.426	2.426	79.382	0.207	3.298	-1.504	-1.984	-0.002	27.013	996.213	99	1
20	10:08:43	158	2006	980533983.966	24.354	2.567	2.567	71.194	-0.416	3.259	-1.504	-1.984	-0.002	26.979	996.085	90	10
21	11:08:25	158	2006	980533982.839	26.103	2.692	2.692	51.486	-0.881	3.141	-1.504	-1.984	-0.002	26.969	995.692	94	6
22	12:08:23	158	2006	980533979.833	22.849	2.332	2.332	24.172	-1.084	2.960	-1.504	-1.984	-0.002	27.014	995.087	96	4
23	13:08:12	158	2006	980533980.998	26.666	2.708	2.708	-5.151	-0.975	2.799	-1.504	-1.984	-0.002	26.960	994.551	97	3
24	14:08:24	158	2006	980533990.195	23.972	2.434	2.434	-31.185	-0.584	2.679	-1.504	-1.984	-0.002	26.958	994.151	97	3
25	15:08:16	158	2006	980533987.632	22.834	2.307	2.307	-49.298	-0.022	2.548	-1.504	-1.984	-0.002	26.933	993.713	98	2
26	16:08:15	158	2006	980533977.898	27.702	2.770	2.770	-57.639	0.563	2.418	-1.504	-1.984	-0.002	26.940	993.280	100	0
27	17:08:11	158	2006	980533982.753	17.431	1.752	1.752	-56.804	1.011	2.355	-1.504	-1.984	-0.002	26.944	993.069	99	1
28	18:08:11	158	2006	980533986.769	19.828	1.993	1.993	-49.803	1.196	2.387	-1.504	-1.984	-0.002	26.942	993.176	99	1
29	19:08:24	158	2006	980533982.554	17.961	1.862	1.862	-41.028	1.057	2.445	-1.504	-1.984	-0.002	26.938	993.369	93	7
30	20:08:15	158	2006	980533983.606	11.958	1.202	1.202	-35.035	0.618	2.621	-1.504	-1.984	-0.002	26.970	993.956	99	1
31	21:08:15	158	2006	980533981.841	14.157	1.416	1.416	-34.896	-0.023	2.752	-1.504	-1.984	-0.002	27.001	994.393	100	0
32	22:08:19	158	2006	980533984.939	10.829	1.100	1.100	-41.495	-0.710	2.873	-1.504	-1.984	-0.002	26.999	994.796	97	3
33	23:08:20	158	2006	980533984.583	18.736	1.893	1.893	-53.090	-1.272	2.935	-1.504	-1.984	-0.002	27.011	995.004	98	2
34	00:08:17	159	2006	980533986.740	12.225	1.241	1.241	-65.810	-1.563	2.955	-1.504	-1.984	-0.002	26.994	995.070	97	3
35	01:07:49	159	2006	980533981.978	14.164	1.461	1.461	-74.734	-1.505	2.921	-1.504	-1.984	-0.002	27.044	994.957	94	6

36	02:08:13	159	2006	980533982.188	12.415	1.254	1.254	-75.381	-1.096	2.930	-1.504	-1.984	-0.002	27.055	994.988	98	2


Sets
Cumulative Mean: 980533984.06 µGal +/- 2.20 µGal +/- 0.37 µGal
10.0
7.5
5.0
2.5
0.0
-2.5
-5.0
-7.5
-10.0
µGal
15:00
18:00
21:00
Wed 7
3:00
6:00
9:00
12:00
15:00
18:00
21:00
Thu 8
Tue 6 Jun 2006
Time


Set Corrections
Set: 36
Tide
50
0
-50
Load
1
0
-1
Polar
-1.4
-1.5
-1.6
Baro
3
2
1
Datum
-2
-2
-2
RefXo
-0.0018
-0.0019
3
6
9
12
15
18
21
24
27
30
33
36
Set Number


Set Sensors
Set: 36
Temp
27.2
27.1
27.0
Pump
0.01100
0.01075
0.01050
Spring
27.5
25.0
Laser
-0.14
-0.15
-0.16
-0.17
Baro
995.0
992.5
990.0
3
6
9
12
15
18
21
24
27
30
33
36
Set Number

8-9 June 2006

STATION: TURIN

City:	Turin	Country:	Italy
Location:	INRIM	Particularity:	
Situation:	Gravity Laboratory	Remarks:	
Date:	8/9 June 2006		

Code number:	
Latitude:	45.0170 degrees
Longitude:	7.64270 degrees
Elevation:	236 m
Gradient:	-2.645 μgal/cm
Reference height:	12.85 mm
Meter:	FG5
S/N:	216

Ocean loading correction (μgal, -Greenwich degree)

Wave	M_2	S_2	K_1	O_1	N_2	P_1	K_2	Q_1	M_f	M_m	S_{sa}
Ampl.	1.675	0.566	0.250	0.147	0.353	0.077	0.156	0.043	0.0	0.0	0.0
Phase:	61.6	33.5	56.6	159.5	83.2	62.1	39.1	-139.5	0.0	0.0	0.0

Polar motion correction			**Air pressure correction**	
X-coordinate:	0.1232	arc seconds	Nominal air pressure:	985.22 mbar
Y-coordinate:	0.3271	arc seconds	Barometric admittance factor:	0.3 μgal/mbar

Gravity

Set gravity mean:	**9 80 533 984.37**	Microgal
Set std. dev.:	0.53	microgal
Mean std. dev.:	20.46	microgal
Number of sets:	12	
Number of drops per set:	200	
Drop interval:	5 seconds	
Set interval:	60 minutes	
Nominal/datum height:	130.0 cm	

Author: O. Francis University of Luxembourg

Date: September 20,2006

Project file

Micro-g Solutions g Processing Report
File Created: 09/20/06, 15:07:16

Project Name: tu20060608
g Acquisition Version: 1.082300
g Processing Version: 6.060320

Company/Institution: ECGS
Operator: O. Francis

Station Data
Name: TURIN
Site Code: IMGC
Lat: 45.01700 Long: 7.64270 Elev: 236.00 m
Reference Height: 12.85 cm
Datum Height: 130.00 cm
Gradient: -2.645 µGal/cm
Nominal Air Pressure: 985.22 mBar
Barometric Admittance Factor: 0.30
Polar Motion Coord: 0.1232 " 0.3271 "
Earth Tide (ETGTAB) Selected
Potential Filename: C:\Program Files\Micro-g Solutions Inc\gWavefiles\Etcpot.dat
Delta Factor Filename: F:\ABSOLU\DATA\2006\Turin\torino.dff
Delta Factors

Start	Stop	Amplitude	Phase	Term
0.000000	0.002427	1.000000	0.0000	DC
0.002428	0.249951	1.160000	0.0000	Long
0.721500	0.906315	1.154250	0.0000	Q1
0.921941	0.974188	1.154240	0.0000	O1
0.989049	0.998028	1.149150	0.0000	P1
0.999853	1.216397	1.134890	0.0000	K1
1.719381	1.906462	1.161720	0.0000	N2
1.923766	1.976926	1.161720	0.0000	M2
1.991787	2.002885	1.161720	0.0000	S2
2.003032	2.182843	1.161720	0.0000	K2
2.753244	3.081254	1.07338	0.0000	M3
3.791964	3.937897	1.03900	0.0000	M4

Ocean Load ON, Filename: F:\ABSOLU\DATA\2006\Turin\torino.olf

Waves:	M2	S2	K1	O1	N2	P1	K2	Q1	Mf	Mm	Ssa
Amplitude (µGal):	1.675	0.566	0.250	0.147	0.353	0.077	0.156	0.043	0.000	0.000	0.000
Phase (deg):	61.6	33.5	56.6	159.5	83.2	62.1	39.1	-139.5	0.0	0.0	0.0

Instrument Data
Meter Type: FG5
Meter S/N: 216
Factory Height: 116.40 cm
Rubidium Frequency: 10000000.01020 Hz
Laser: WEO100 (187)
ID: 632.99117754 nm (0.33 V)
IE: 632.99119473 nm (-0.14 V)
IF: 632.99121259 nm (-0.55 V)
IG: 632.99123023 nm (-0.93 V)
IH: 632.99136890 nm (-1.78 V)
II: 632.99139822 nm (-1.53 V)
IJ: 632.99142704 nm (-1.30 V)
Modulation Frequency: 8333.420 Hz

Processing Results

Date: 06/08/06
Time: 21:57:43
DOY: 159
Year: 2006
Time Offset (D h:m:s): 0 0:0:0
Gravity: 980533984.37 µGal
Set Scatter: 0.53 µGal
Measurement Precision: 0.15 µGal
Total Uncertainty: 0.15 µGal
Number of Sets Collected: 12
Number of Sets Processed: 12
Set #s Processed: 1,2,3,4,5,6,7,8,9,10,11,12
Number of Sets NOT Processed: 0
Set #s NOT Processed:
Number of Drops/Set: 200
Total Drops Accepted: 2330
Total Drops Rejected: 70
Total Fringes Acquired: 700
Fringe Start: 7
Processed Fringes: 613
GuideCard Multiplex: 4
GuideCard Scale Factor: 250

Acquisition Settings
Set Interval: 60 min
Drop Interval: 5 sec
Number of Sets: 12
Number of Drops: 200

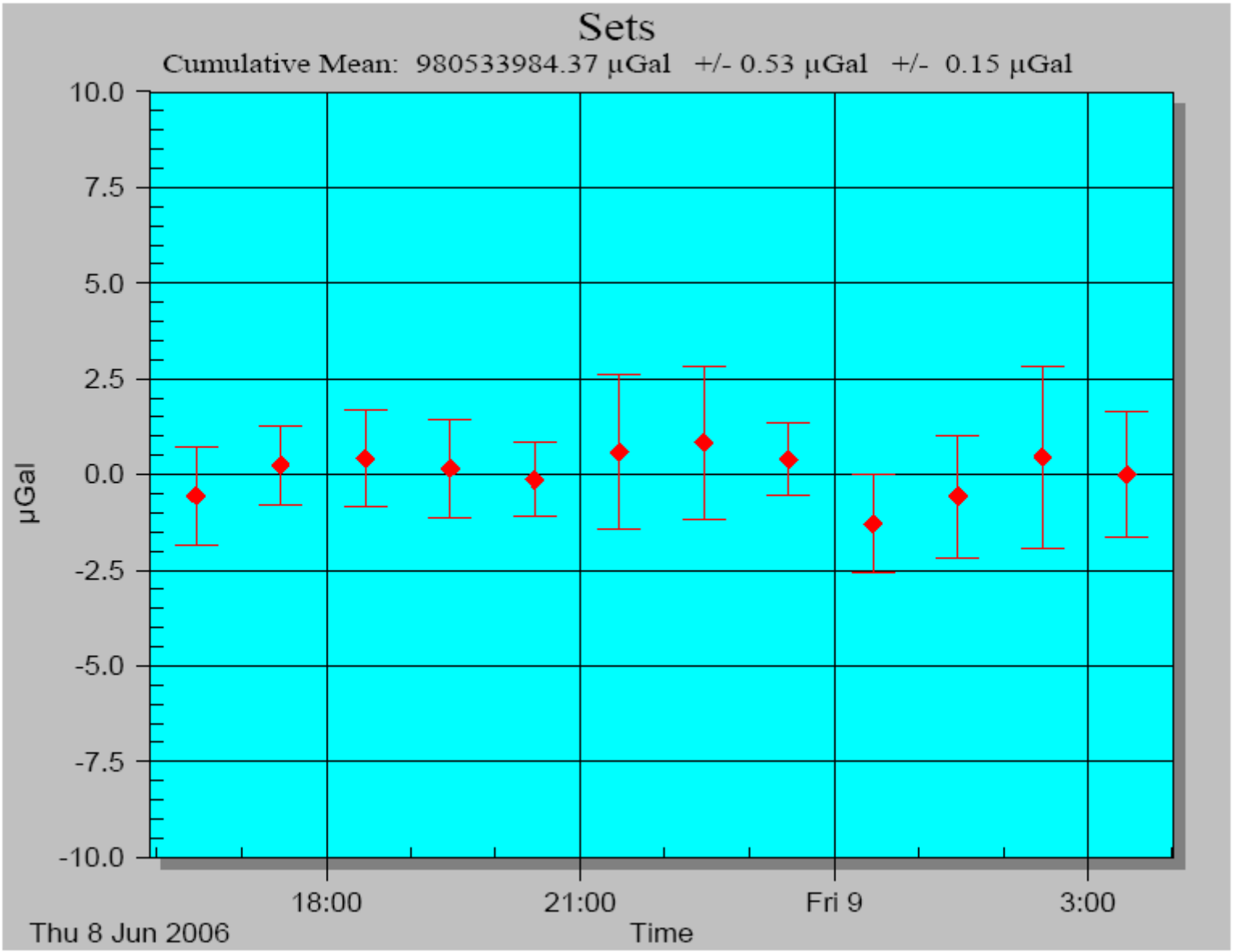
Gravity Corrections
Earth Tide (ETGTAB): -63.40 µGal
Ocean Load: -0.13 µGal
Polar Motion: -1.50 µGal
Barometric Pressure: 2.78 µGal
Datum Height: -1.98 µGal
Reference Xo: -0.00 µGal

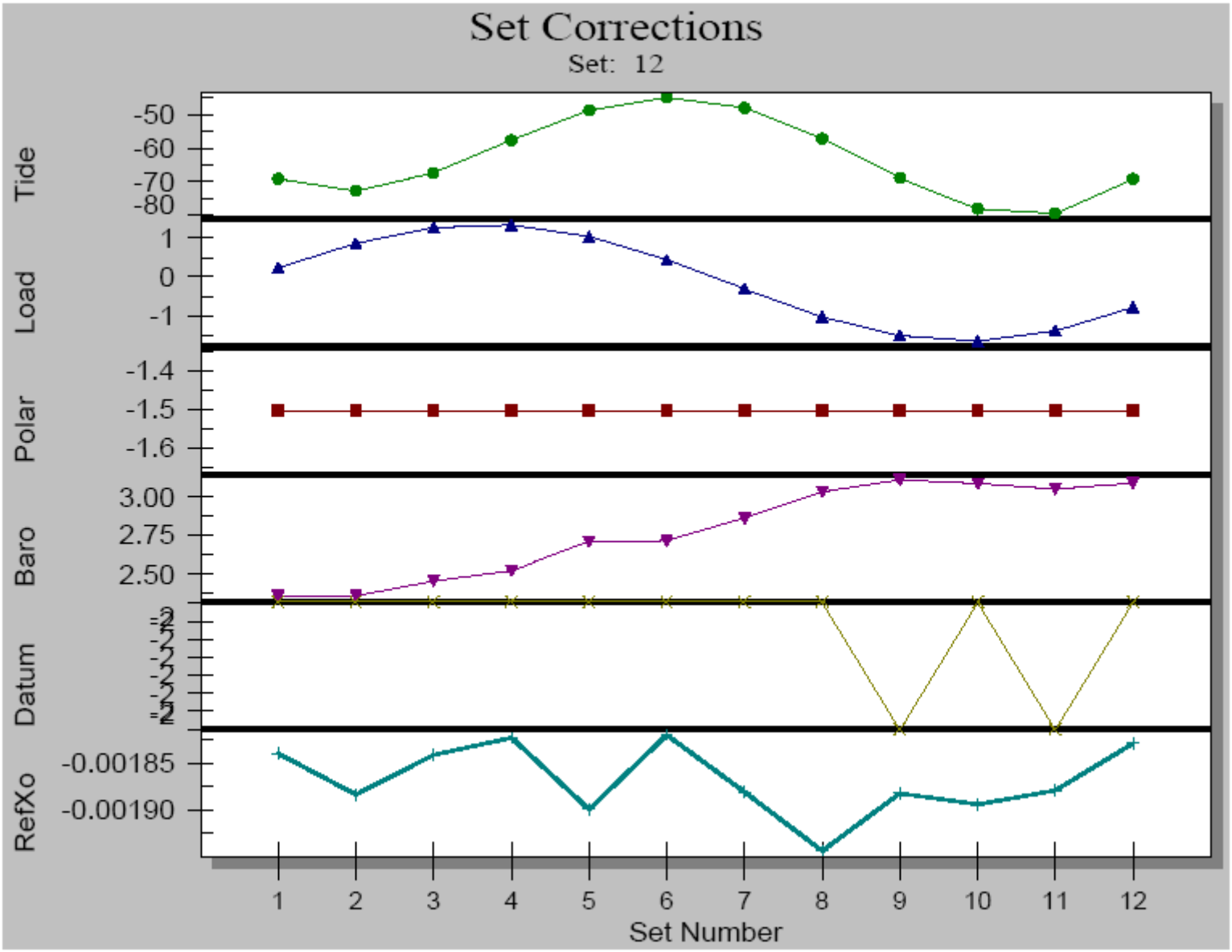
Uncertainties
Sigma Reject: 3.00
Earth Tide Factor: 0.000
Average Earth Tide Uncertainty: 0.00 µGal
Ocean Load Factor: 0.00
Average Ocean Load Uncertainty: 0.00 µGal
Barometric: 0.00 µGal
Polar Motion: 0.00 µGal
Laser: 0.00 µGal
Clock: 0.00 µGal
System Type: 0.00 µGal
Tidal Swell: 0.00 µGal
Water Table: 0.00 µGal
Unmodeled: 0.00 µGal
System Setup: 0.00 µGal
Gradient: 0.00 µGal (0.00 µGal/cm)

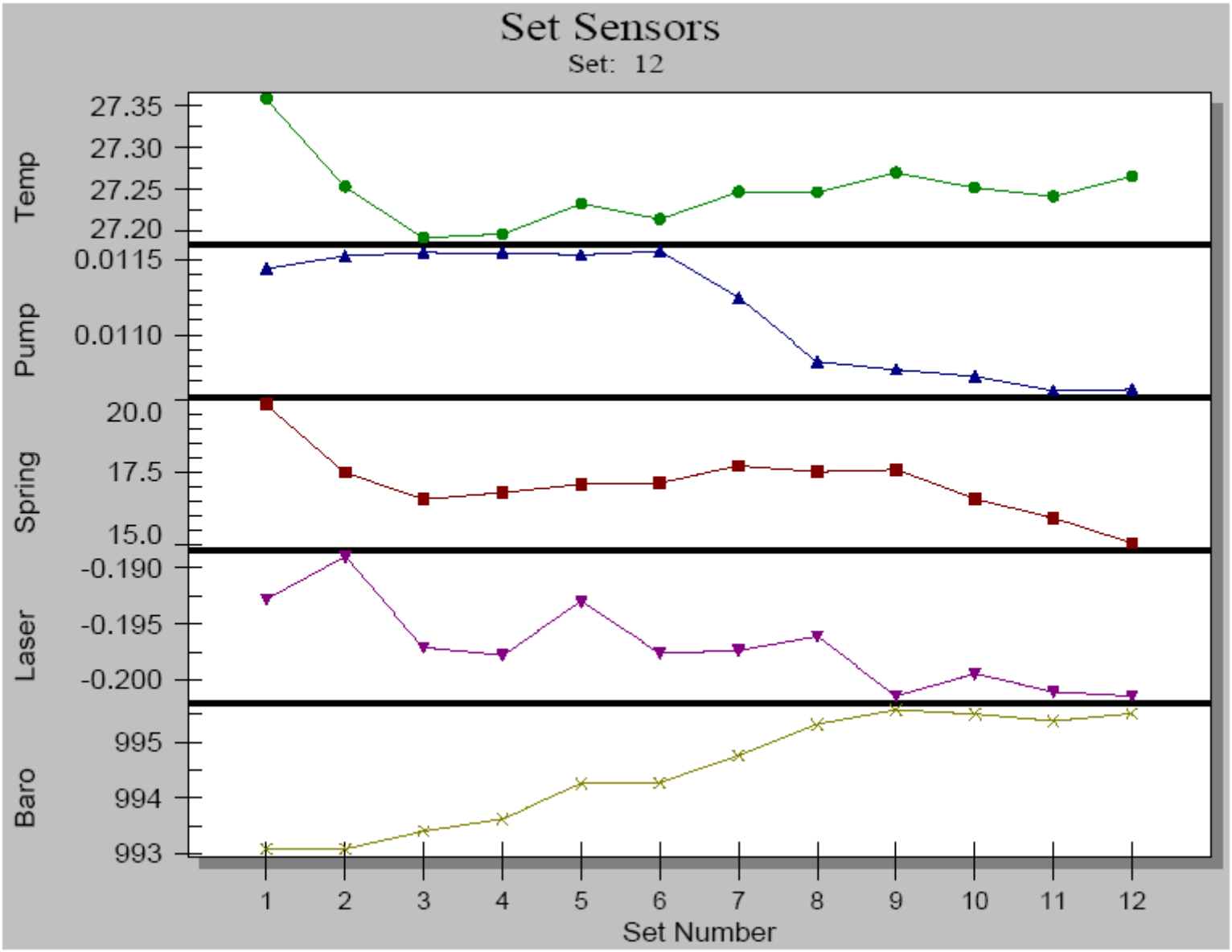
Set File

Source Data Filename: tu20060608
g Acquisition Version: 1.082300
g Processing Version: 6.060320

Set	Time	DOY	Year	Gravity	Sigma	Error	Uncert	Tide	Load	Baro	Polar	Datum	Refxo	Temp	Pres	Accept	Reject
1	16:27:40	159	2006	980533983.815	17.845	1.268	1.268	-69.102	0.227	2.359	-1.504	-1.984	-0.002	27.359	993.084	198	2
2	17:27:37	159	2006	980533984.621	14.359	1.023	1.023	-72.712	0.862	2.360	-1.504	-1.984	-0.002	27.254	993.086	197	3
3	18:27:41	159	2006	980533984.789	17.595	1.260	1.260	-67.340	1.270	2.456	-1.504	-1.984	-0.002	27.193	993.407	195	5
4	19:27:40	159	2006	980533984.531	17.862	1.266	1.266	-57.606	1.337	2.522	-1.504	-1.984	-0.002	27.197	993.625	199	1
5	20:27:41	159	2006	980533984.237	13.360	0.967	0.967	-48.697	1.037	2.711	-1.504	-1.984	-0.002	27.234	994.256	191	9
6	21:27:45	159	2006	980533984.965	27.975	2.003	2.003	-44.826	0.437	2.716	-1.504	-1.984	-0.002	27.215	994.275	195	5
7	22:27:43	159	2006	980533985.209	28.101	1.997	1.997	-47.941	-0.313	2.862	-1.504	-1.984	-0.002	27.247	994.760	198	2
8	23:27:48	159	2006	980533984.779	13.304	0.953	0.953	-57.140	-1.026	3.032	-1.504	-1.984	-0.002	27.247	995.325	195	5
9	00:27:46	160	2006	980533983.091	17.781	1.293	1.293	-68.879	-1.516	3.109	-1.504	-1.984	-0.002	27.270	995.582	189	11
10	01:27:48	160	2006	980533983.811	22.282	1.600	1.600	-78.057	-1.652	3.086	-1.504	-1.984	-0.002	27.252	995.507	194	6
11	02:27:44	160	2006	980533984.825	32.041	2.362	2.362	-79.402	-1.389	3.050	-1.504	-1.984	-0.002	27.242	995.387	184	16
12	03:27:42	160	2006	980533984.377	22.957	1.644	1.644	-69.056	-0.781	3.088	-1.504	-1.984	-0.002	27.266	995.513	195	5


Sets
Cumulative Mean: 980533984.37 µGal +/- 0.53 µGal +/- 0.15 µGal
10.0
7.5
5.0
2.5
0.0
-2.5
-5.0
-7.5
-10.0
µGal
18:00
21:00
Fri 9
3:00
Thu 8 Jun 2006
Time


Set Corrections
Set: 12
Tide
-50
-60
-70
-80
Load
1
0
-1
Polar
-1.4
-1.5
-1.6
Baro
3.00
2.75
2.50
Datum
RefXo
-0.00185
-0.00190
1
2
3
4
5
6
7
8
9
10
11
12
Set Number


Set Sensors
Set: 12
Temp
27.35
27.30
27.25
27.20
Pump
0.0115
0.0110
Spring
20.0
17.5
15.0
Laser
-0.190
-0.195
-0.200
Baro
995
994
993
1
2
3
4
5
6
7
8
9
10
11
12
Set Number